In re Application of: Noam EGOZI
Serial No.: 10/526,428
Filed: February 28, 2005
Office Action Mailing Date: December 14, 2010

Examiner: Sanjay CATTUNGAL
Group Art Unit: 3768
Attorney Docket: **39878**
Confirmation No.: 5344

In the Claims:

1. (Currently Amended) A method of detecting gas bubbles in a living body, comprising:

transmitting at least one original electromagnetic signal to a body portion;

detecting ~~a~~ said signal modulated by a flow of blood in said body portion; and

analyzing a perturbation in said detected signal to determine at least one of an existence and a property of a bubble in said blood flow,

wherein said transmitting, said detecting and said analyzing are carried out by a device worn on said body.

2. (Original) A method according to claim 1, wherein said original signal comprises a series of pulses.

3. (Original) A method according to claim 1, wherein said detected signal comprises a reflected signal.

4. (Original) A method according to claim 1, wherein said detected signal comprises a signal modulated by transmission through said flow.

5. (Original) A method according to claim 1, wherein said signal comprises a narrow bandwidth signal.

6. (Original) A method according to claim 1, wherein said signal is visible light.

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7. (Original) A method according to claim 1, wherein said signal is infra-red light.

8. (Original) A method according to claim 1, wherein said signal is at a wavelength which is selectively absorbed by hemoglobin.

9. (Original) A method according to claim 1, wherein said signal is at a wavelength which is selectively reflected by blood vessel walls.

10. (Original) A method according to claim 1, wherein said detected signal is detected using multiple detectors.

11. (Original) A method according to claim 1, wherein said original signal comprises multiple original signals from multiple sources.

12. (Original) A method according to claim 11, wherein said sources are arranged around a body part in which said bubbles are to be detected.

13. (Original) A method according to claim 11, wherein said sources are arranged to view multiple parts of a body.

14. (Original) A method according to claim 11, wherein said signals are detected in series.

15. (Original) A method according to claim 11, wherein said signals have different wavelengths.

16. (Original) A method according to claim 15, wherein at least two of said different wavelengths have different absorption properties in blood.

17. (Original) A method according to claim 1, wherein analyzing comprises combing the effects of said multiple sources.

18. (Withdrawn) A method according to claim 6, comprising performing AM on said detected signal.

19. (Withdrawn) A method according to claim 18, wherein said AM analysis comprises estimating an unperturbated signal and counting zero crossings relative to said estimation.

20. (Withdrawn) A method according to claim 19, wherein said estimation is selected to preclude the detection of perturbations below a certain threshold.

21. (Withdrawn) A method according to claim 19, wherein said estimation comprises an adaptive threshold.

22. (Withdrawn) A method according to claim 19, wherein said estimation reduces the effect of systolic-caused changes in said signal.

23. (Withdrawn) A method according to claim 18, comprising performing FM on said detected signal.

24. (Withdrawn) A method according to claim 23, comprising combining said AM analysis and said FM analysis.

25. (Withdrawn) A method according to claim 6, comprising performing FM on said detected signal.

26. (Withdrawn) A method according to claim 25, wherein said FM analysis comprises applying a frequency transform to said detected signal.

27. (Withdrawn) A method according to claim 25, wherein said FM analysis comprises detecting changes in a delay time of a said detected signal relative to said original signal.

28. (Withdrawn) A method according to claim 25, wherein said FM analysis comprises detecting a change in amplitude of a frequency component.

29. (Withdrawn) A method according to claim 6, comprising analyzing said received signal to determine a value or a change in a physiological parameter other than bubbles.

30. (Withdrawn) A method according to claim 29, wherein said physiological parameter comprises a heart rate.

31. (Withdrawn) A method according to claim 29, wherein said physiological parameter comprises an oxygen saturation.

32. (Withdrawn) A method according to claim 29, wherein said physiological parameter comprises one or both of a respiration rate and a respiratory capacity.

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33. (Withdrawn) A method according to claim 6, wherein said analyzing comprises estimating a number of bubbles.

34. (Withdrawn) A method according to claim 6, wherein said analyzing comprises estimating a volume of bubbles.

35. (Withdrawn) A method according to claim 6, wherein said analyzing comprises tracking the formation of at least one bubble.

36. (Withdrawn) A method according to claim 6, wherein said analyzing estimating a diameter of at least one bubble.

37. (Withdrawn) A method according to claim 6, comprising estimating a physiological state for diving purposes based on said analysis.

38. (Withdrawn) A method according to claim 6, wherein transmitting comprises transmitting when in contact with a skin surface.

39. (Original) A method according to claim 1, wherein transmitting comprises transmitting through a layer of water.

40. (Original) A method according to claim 39, wherein said layer is between 1 and 20 mm thick.

41. (Withdrawn) A method of detecting gas bubbles in a living body, comprising:

transmitting at least one original optical signal to a body portion; detecting a signal modulated by a flow of blood in said body portion; and

analyzing, using AM analysis, a perturbation in said signal to determine at least one of an existence and a property of a bubble in said blood flow,

wherein said transmitting and analyzing are by a wearable device.

42. (Canceled)

43. (Withdrawn and Currently Amended) A method according to claim ~~42~~ 41, comprising applying an FM analysis.

44. (Previously Presented) Wearable apparatus for bubble detection, comprising:

at least one electromagnetic signal source adapted to transmit a wave into a body;

at least one sensor adapted to receive said signal after modulation by a flow in said body; and

circuitry adapted to analyze said received signal and detect the presence of a bubble in said flow.

45. (Original) Apparatus according to claim 44, wherein said circuitry is adapted to self-calibrate said apparatus.

46. (Original) Apparatus according to claim 44, wherein said circuitry is adapted to detect if a placement of said device is suitable.

47. (Withdrawn) Apparatus according to claim 44, wherein said wave is optical and wherein said device is adapted to be worn on a wrist.

48. (Withdrawn) Apparatus according to claim 44, wherein said wave is optical and wherein said device is adapted for underwater use during diving.

49. (Original) Apparatus according to claim 44, comprising a wireless link.

50. (Original) Apparatus according to claim 44, comprising a user input for providing task related information.

51. (Withdrawn) Wearable apparatus for physiological tracking bubble detection, comprising:

at least one electromagnetic signal source adapted to transmit an optical light wave into a body;

at least one sensor adapted to receive said signal after modulation by a flow in said body; and

circuitry adapted to analyze said received signal and detect at least changes in at least two physiological parameters of said body.

52. (Withdrawn) Apparatus according to claim 51, wherein said at least two physiological parameters are selected from a group comprising, existence of bubbles, heart rate, respiration rate, blood pressure, oxygen saturation and vascular response.

53. (Currently Amended) A method of bubble tracking in a living body, comprising:

transmitting at least one original electromagnetic signal to a body portion;

detecting ~~a~~ said signal modulated by a bubble in said body portion; and

analyzing a perturbation in said detected signal to determine at least one of an existence and a change in size of a bubble in said body portion,

wherein said transmitting, detecting and analyzing are performed by a wearable device.

54. (Previously presented) A method according to claim 1, wherein said signal is at a wavelength which is sensitive to motion of the sensor.

55. (Previously presented) A method according to claim 54, wherein the wavelength is not selectively reflected by blood vessel walls.

56. (Previously presented) A method according to claim 1, wherein said signal is at a wavelength suitable for viewing through fat tissue.

57. (Previously presented) A method according to claim 15, wherein the different wavelengths respond differently to bubbles.

58. (Previously presented) A method according to claim 15, also comprising using the signals of different wavelengths for one or more of estimating an effect of intervening tissue, looking at different depths in tissue, and looking at the flow of blood in different sized blood vessels.

59. (Withdrawn) A method according to claim 32, wherein the physiological parameter comprises a respiration rate, and determining the value or change in the physiological parameter comprises determining the respiration rate from a measured systolic wave.

60. (Withdrawn) A method according to claim 29, wherein said physiological parameter comprises one or more of a pulse form, a cardiac output, a blood flow rate, a blood volume, a blood pressure**,** and a systemic vascular resistance.

61. (Withdrawn) A method according to claim 60, wherein the physiological parameter comprises a local blood flow rate to an organ, and the method also comprises using a change in the local blood flow rate to estimate a change in a physiological condition of the body as a whole.

62. (Withdrawn) A method according to claim 29, wherein a user selects one or more such physiological parameters.

63. (Withdrawn) A method according to claim 62, also comprising displaying one or more such physiological parameters selected by the user.

64. (Withdrawn) A method according to claim 6, wherein analyzing comprises estimating a growth rate of bubbles.

65. (Previously presented) A method according to claim 1, done under water, in the air or in outer space.

66. (Withdrawn) A method according to claim 6, comprising estimating a physiological state based on said analysis, in air or in outer space.

67. (Withdrawn) A method according to claim 37, comprising using a change in the physiological state to predict problems during a dive, and to indicate where certain action should be taken or is imminent.

68. (Withdrawn) A method according to claim 67, wherein the change in the physiological state comprises one or more of appearance of bubbles, reduction in cardiac output, and increase in stress.

69. (Withdrawn) A method according to claim 67, wherein using the change in the physiological state to predict problems comprises adapting the prediction to a person doing the diving based on a real-time response of the person.

70. (Withdrawn) A method according to claim 6, comprising estimating a physiological state using multiple measured parameters, taking into account the interaction of the parameters.

71. (Previously presented) A method according to claim 1, wherein transmitting comprises transmitting through air.

72. (Withdrawn) A method according to claim 1, wherein transmitting comprises transmitting through clothing.

73. (Withdrawn) A method according to claim 1, wherein transmitting comprises transmitting through an intermediate layer.